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Effectiveness of a Self-Static Stretching Strengthening Program on Work-Related Musculoskeletal Disorders in Market-Vendors; A Quasi-Experimental Study

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Abstract— *The Self-Static Stretching Strengthening program was designed as an individual exercise program to relieve work-related musculoskeletal disorder in market-vendors. The aim of this study was to compare before and after the 1-month intervention program in market-vendors in Bangkok, Thailand. The 143 market-vendors who had muscle pain or muscle discomfort at upper or lower limbs region participated in this study. They were divided into 2 groups, intervention group, and control group, based on the market location. Both groups were assessed muscle flexibility and grip strength at baseline and after the 1-month intervention program. The Mann Whitney u test and Wilcoxon signed-rank test were used for comparison before and after a 1-month intervention between and within the group, respectively. The result showed the pain intensity in the intervention group decreased more than the control group significantly (p=0.036) after a 1-month intervention program. The muscle flexibility between 2 groups after a 1-month intervention showed a significant difference in left-arm flexibility, right and left leg flexibility (p=0.005, p <0.001, p<0.001, respectively). However, there was no significant difference in grip strength between 2 groups. In conclusion, The Self-Static Stretching Strengthening program can improve lower limb flexibility but cannot increase upper limb flexibility and grip strength.*

Keywords— *Stretching exercise, Work-related musculoskeletal disorders, Market-vendor, Muscle flexibility, Grip strength*.

I. INTRODUCTION

Work-related musculoskeletal disorder (WRMDs) often occurs in workers. About 20%–30% of people across the global live with a painful musculoskeletal condition [1]. About 25% of worker in the Europe and 40% of worker in the United State of America reported musculoskeletal disorder [2]. In Thailand, Department of Labor Protection and Welfare, DLPW reported 84.54% of workers have to leave work due to musculoskeletal disorder in 2017 [3]. Muscle tightness and weakness were reported as a symptom of work-related musculoskeletal disorder (WRMDs) [4]. The inadequate muscle flexibility and muscle strength can reduce ability of body movement to perform tasks properly. A market-vendor is the person who sells food or goods in market. In Thailand, the National statistic surveyed and reported that there were 23.13% of employed person in Bangkok who work in wholesale and retail trade industry [5]. WRMDs often occurs in market-vendor because of work characteristics such as prolonged sitting and standing, arm repetition working, lifting heavy load and awkward posture [6]. They often ignore the symptom or sign of WRMDs because they need to work every day due to the financial reason. Although they have knowledge for reduce muscle tightness or improve muscle strength, they rarely perform stretching and strengthening exercise because they are not interested in exercise and they have no time for exercise.

A stretching exercise is well known that it can relieve muscle tightness or muscle pain in workers, but some workers often ignore or perform it incorrectly. The previous study was a systematic review that recruited 9 articles showed the result that stretching exercise helped to reduce muscle discomfort and pain in computer worker, manufacturing worker, firefighters, and military worker. However, all articles were a low methodological quality of studies. For the further study, it should has a control group and clear stretching exercise program [7].

This study designed Self-Static Stretching Strengthening program for the market vendors. This intervention program was combined between self-static stretching exercise which focused on arms, trunk and legs and the 600-cc of water bottle weight training which focused on upper limbs. It was designed by physical therapist based on guideline of American Collage of Sport Medicine [8]. It was simple and easy program to perform at shop or home for individual exercise because almost market-vendors had no time for group exercise due to work conditions and their burdens. The objective of this study was to compare muscle flexibility and grip strength before and after 1-month intervention program in market vendors at Bangkok, Thailand.

II. METHOD

This is a quasi-experimental study to compare muscle flexibility and grip strength before and after 1-month intervention program. This study was carried out in the

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Samyan and Ortorkor markets, both in Bangkok, Thailand. Both are permanent government-controlled markets and in a business and commercial center urban area

A. Subject

The market-vendors from 2 markets participated in this study. They were 18-64 of age who have worked in the market for at least 1 year and they had muscle pain or muscle discomfort at upper or lower limbs region with pain intensity at least 3 and over on a scale of 0 to 10. They were excluded if they had physical problems that limited exercise.

Base on convenience selection, the market-vendors in the Samyan market were placed into the intervention group and in the Ortorkor market were placed into the control group. At the beginning, the total 63 participants from intervention group and 150 from control group were recruited to this study by volunteer. After baseline measurement, 143 participants (intervention group; n=60 and control group; n=82) who met the criteria were selected to this study. After 1-momth intervention, 59 participants from intervention group finished Self-Static Stretching Strengthening program. Thus, the total 141 the participants (intervention group; n=59 and control group; n=82) performed post-test measurement.

B. Materials and Procedure

The market vendors were approached by the interviewers with underwent considerable training by the researcher. After successful training on the interview and measurement technique, 3 interviewers began the field process. At the beginning, all participants were required to complete a questionnaire and muscle flexibility and grip strength assessment. The questionnaires consisted of sociodemographic data such as gender, age, height, duration of working and working time per day.

Primary outcomes were muscle pain, muscle flexibility and grip strength. All outcome variables were assessed at baseline and after 1-month intervention. Visual analog scale was used for muscle pain intensity evaluation. The scale has been reported reliability showed moderate to good in patients with chronic musculoskeletal pain [9]. The participants were asked to point their pain level on this straight line. The distance between zero and ten can be defines participant's pain level [10]. Back scratch test and chair sit and reach test used a guideline from Sports Authority of Thailand [11]. These were used for muscle flexibility at upper limbs and lower limbs, respectively, and were designed for the field test. The participants practiced two times, and then tested three times. Three results were averaged and recorded in data collection form. Grip strength was assessed by handgrip dynamometer (Takei Hand Grip Dynamometer, TKK 5401, Japan). It was regularly used for representation overall muscle strength in medical and sport practices [12]. The participants performed 3 times of testing with 10-20 seconds paused between each trial to avoid the effects of muscle fatigue. The maximum number was chosen and divided by weight.

Self-static stretching strengthening exercise program was the intervention program. It was specific program that focused on improved grip strength and muscle flexibility of upper and lower limbs and contained 6 stretching exercises and a water bottle weight exercise. The stretching exercises composed of Cross-Chest Stretch, Triceps Stretch, Biceps Stretch, Body stretch, Thigh stretch and Calf and foot stretch. According to American Collage of Sport Science's guideline for stretching exercise, the exercise protocol was move slowly to end point of tightness, hold for 10 seconds, repeat 3 times and perform 2 time in every day. A water bottle weight exercise used 600-cc. of water bottle as external load. There were 4 steps, 1) bend elbows slowly, 2) Rise arms with stretch elbow overhead, 3) bend elbows behind the head slowly and then straighten arms and 4) put arms down. This exercise repeated 10 times per session, at least 2 times a day in every day.

This program was performed in only intervention group for a month. The participants were conducted this program 3 days a week at the market by 5 trained physical therapists and using public radio broadcast to guideline them. They were asked to do this program at home by themselves 4 days a week. Both groups received ergonomic brochure that consisted of knowledges about corrected posture of sitting, standing, and lifting heavy load.

C. Ethical Considerations

This study was approved by The Ethics Review Committee for Research Involving Human Research Subjects, Health Science Group, Chulalongkorn University. Research assistance told the participants about the study protocol and the risk of exercise before they signed a consent form.

D. Statistical Analysis

The $\chi 2$ tests was used for checking the differences between non-parametric variables were studied. The Kolmogorov-Smirnov Goodness of Fit Test was used to normality test. The result showed that there was no normal distribution in all variables. As the main objective of this study was to compare muscle flexibility and grip strength before and after 1-month intervention program. Thus, the Mann Whitney u test and Wilcoxon signed rank test were used for comparison before and after 1-month intervention between group and within group, respectively. All results with $p<0.05$ was considered statistically significant. The data analysis was performed using SPSS 22.0 for Windows.

III. Result

The total 141 the participants (intervention group; n=59 and control group; n=82) were participated in this study. The socio-demographic data and outcome variables were similar between both groups and showed in table 1. The result revealed that selling and shop arrangement were the main of job responsibility in both groups. Most of participants has worked in the market for 10 years and over and about 90% work every day. The result showed more than 50% of participant had static standing or sitting more than 4 hours during working time due to job responsibility.

At the beginning, all participants had muscle pain or muscle discomfort at upper or lower limbs region in past 7 day. The visual analog scale showed pain intensity in intervention group was 4.98±2.19 and control group showed 5.74±1.09. About 65% of all participants had musculoskeletal disorder more than 1 area. The table 1 showed the frequency

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and the percentage of muscle pain in past 7 day, it was similar between both groups. The highest frequency area was shoulders in intervention group. The control group showed the highest frequency area was legs and feet.

TABLE 1. the baseline characteristics and outcome variables

Baseline characteristics	Intervention group (N=59)	Control group (N=82)	*p*-value
Gender+			
Male	11 (18.64)	22 (26.83)	0.26
Female	48 (81.36)	60 (73.17)	
Age (year) ++	50.19±12.57	45.88±13.70	0.07
Height (cm.) ++	158.80±6.82	159.66±7.72	0.62
Weight (kg.) ++	62.52±13.00	62.94±12.66	0.88
BMI (kg/m^2) ++	24.71±4.49	24.63±4.20	0.89
Regular exercise+			
Yes	21 (35.6)	18 (22.0)	0.09
No	38 (64.4)	64 (78.0)	
Duration of working (year) ++	16.03±12.57	11.35±9.72	0.02*
Working time per day (hour) ++	9.31±1.91	11.15±1.62	<0.001*
Pain area			
Neck and thoracic+	15 (25.42)	24.39	0.89
Shoulders +	24 (40.68)	32.93	0.37
Arms+	12 (20.34)	9.76	0.08
Hands +	9 (15.25)	7.32	0.32
Lower back+	12 (20.34)	32.93	0.10
Legs and feet+	23 (38.98)	52.44	0.11
Outcome variable			
Right arm muscle flexibility (cm.) ++	-1.62±4.89	-3.84±7.32	0.07
Left arm muscle flexibility (cm.) ++	-3.88±6.98	-5.61±9.07	0.39
Right leg muscle flexibility (cm.) ++	0.20±5.86	-0.60±3.62	0.45
Left leg muscle flexibility (cm.) ++	-0.45±5.35	-0.72±3.72	0.29
Right arm grip strength (kg/m^2) ++	0.39±0.11	0.41±0.13	0.53
Left arm grip strength (kg/m^2) ++	0.38±0.14	0.39±1.37	0.67

+Chi-square test
++Mann-Whitney U Test
*significant difference p<0.05

After 1-month intervention program, the pain intensity in intervention group decreased more than control group significantly (p=0.036). In the control group, right and left leg flexibility showed significant decrease (-0.77±3.99 p=0.037, -0.86±4.23 p=0.027, respectively). The intervention group showed significant decrease of left arm flexibility (-3.99±11.39 p=0.008) but improve significantly of right and left leg flexibility (8.21±11.39 p<0.001, 9.05±10.67 p<0.001, respectively). Moreover, comparison muscle flexibility between 2 groups after 1-month intervention showed significantly difference of left arm flexibility, right and left leg flexibility. However, the result presented there was no significant difference in grip strength between 2 groups and within group after 1-month intervention. The table 2 presented mean change of muscle flexibility and grip strength between 2 groups.

TABLE 2. Mean change of muscle flexibility and grip strength

	SSS group (N=59)	Control group (N=82)	*p*-value+
Right arm muscle flexibility	-0.11±6.69	1.94±7.63	0.39
Left arm muscle flexibility	-3.99±11.39#	2.08±9.76	0.005*
Right leg muscle flexibility	8.21±11.39#	-0.77±3.99#	<0.001*
Left leg muscle flexibility	9.05±10.67#	-.086±4.23#	<0.001*
Right arm grip strength	-0.05±0.12	-0.01±0.17	0.81
Left arm grip strength	-0.04±0.15	-0.03±0.16	0.39

+Mann-Whitney U Test
Wilcoxon signed rank test
*significant difference $p<0.05$

IV. Discussion

The study design was experimental and controlled, which suitable for testing the effect of intervention program [13]. The baseline value of variables and outcomes was no difference between 2 groups, except, 1) the intervention group showed shorter working time per day than control group and 2) the intervention group had working duration longer than the control group. The reason for the first and the second issue came from observations, so, it could be the duration of working hour at the control group was longer than intervention group and the Samyan market (intervention place) was established 12 years-before Ortorkor market (control place). However, working time per day and working duration was not the main risk factors of WRMDs among market-vendors. The previous study in Korea surveyed work-related musculoskeletal disorder in different work types. The result showed the ergonomic risk factors in wholesale and retail workers were prolonged sitting and standing, carrying heavy load and repetitive arm movement [6].

The intervention group showed significant decreasing on left arm muscle flexibility after 1-month intervention program. It might be caused by improper exercise posture in this program. The back-scratch test was used for upper limb flexibility assessment. This test, the participant was asked to place one hand over the shoulder behind the head and back, palm touching the body and the fingers directed downwards and move as far as possible down the middle of the back, Another hand place behind back, palm facing outward and fingers upward and move up as far as possible to touch the middle fingers of both hands [11]. The intervention program consisted of Cross-Chest Stretch, Triceps Stretch and Biceps Stretch. These exercise positions focused on deltoid muscle, triceps muscle and bicep muscle stretching, respectively, but back scratch test need flexibility of rotator cuff muscle to act shoulder rotation. Thus, the further study should add the posture of exercise that focus on rotator cuff muscle.

The result showed there was significant difference between groups on changing of left arm muscle flexibility after 1-month intervention program. From the observation, selling and shop arrangement were the main of job responsibility in both groups. However, the control group had a duration of resting during working time more often than the intervention group. There was relation between working break and WRMDs. The previous study showed short duration and high frequency of rest- breaks reduced muscle tightness and fatigue among the company worker [14]. It can be concluded that the market-

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vendor in the intervention group had low frequency of working break and they use both arms for working too much for selling, cooking and shop arrangement. The repetitive arm movement can cause injury at arm muscles, tendons, ligament, and joints because these structures were used for working over and over. So, the musculoskeletal structure must work in the same range of movement that lead to muscle fatigue and injury can occur [4, 15]. Although, the statistic showed the significant difference between groups on changing of left arm muscle flexibility, the control group did not show the difference of changing on left arm muscle flexibility after 1-month intervention program. It can be concluded that the difference between group caused by the significant reducing in the intervention group.

The intervention group showed significant improved leg muscle flexibility after 1-month intervention program and there was difference of changing on both legs muscle flexibility between groups. This change caused by 3 reasons. First, the intervention program had Thigh stretch posture that focused on lower back and thigh muscle stretching. The focusing was similar with chair sit and reach test which is a common measure of flexibility, and specifically measures the flexibility of the lower back and hamstring muscles [11]. Second, muscle flexibility improvement can caused by decreasing muscle tension and muscle pain [16, 17]. This study showed pain intensity decrease in intervention group after 1-month intervention program. The 1-month continuous stretching program showed positive effect to reduce pain among workers. The previous study determined 4-week stretching program. the result reported there was 25% pain decreasing among bus drivers [18]. The last, the intervention program used static stretching method according to the American Collage of Sport Medicine [8]. This method can stimulate the Golgi tendon organ to inhibit alpha motoneuron to release muscle tension, so, the increasing in range of motion due to a decrease of tension, not increased muscle length [19]. Moreover, the previous study showed the minimal clinically important difference (MCID) for sit and reach test was 4 centimeters [20]. The intervention group presented the value of changing in chair sit and reach test was higher than MCID. It can be concluded that this changing caused by the intervention program and likely to be clinically important.

This study showed there was no change in grip strength in both groups and there was no difference between group on grip strength after 1-month intervention program. The main reason might be insufficient of intensity of exercise. According guideline of American Collage of Sport Medicine, the intensity of strengthening exercise is 10 repetition maximum for muscle strength (75% 0f 1RM) [8]. The previous study examined the effect of 12 weeks of wrist and forearm training on male high school baseball players. The exercise protocol was using the 5RM external load and repeated for 5 times in a session and trained 3 days a week for 12 weeks. The finding was significant increases in grip strength after 12 weeks of resisted exercise [21]. But this study used 600 cc water bottle for external load because it was easy and simple to find and use for exercise in market. Another reason was the intervention program did not train the grip muscle that involves flexor digitorum superficialis muscle, flexor digitorum profondus muscle and the flexor policus longus muscle [22]. The arm exercise in this study focused on deltoid muscle, triceps muscle and biceps muscle because these muscles are large group of arm muscle and help the market-vendors to work.

V. Limitations and Recommendations

There were 3 limitations in this study. First, both markets of this study are in urban area. Thus, the result of this study cannot generalize to the market in rural area due to difference lifestyle. Second, the intervention program consisted of stretching and strengthening exercise in large group of muscle in the body. However, small groups of muscle such as forearm muscle or intrinsic muscle should be concerned. Third, the participants were conducted 12 times of exercise session by physical therapist in the market and was asked to practice by themselves at their home during 1-month intervention program. This study had short duration of the program in the market due to avoid the interruption of working time in market-vendor. The further study should apply this program longer than this study and need to follow up the result after finishing the program to determine sustain ability of the exercise program.

VI. Conclusion

The Self-Static Stretching Strengthening program was design as individual exercise program and was easy and simple to perform this program at shop or home. The result showed market-vendor had low muscle flexibility and very low of grip strength. This intervention program can improve lower limbs flexibility in this group but cannot increase upper limbs flexibility and grip strength. The further study should add the posture of exercise that focus on rotator cuff muscle and small group of muscle in forearm and hand. For this program implementation, the result from this study can be used for development the campaign or individual exercise program to improve muscle flexibility and muscle strength and prevent work-related musculoskeletal disorder in market vendors.

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